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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/725,381	12/03/2003	Han-Choon Lee	040044-0306859	3140

909 7590 02/02/2006

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EXAMINER	
DOTY, HEATHER ANNE	

ART UNIT	PAPER NUMBER
2813	

DATE MAILED: 02/02/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/725,381	LEE, HAN-CHOON	
	Examiner	Art Unit	
	Heather A. Doty	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *22 November 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,4,5,8,9 and 12-17* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) *1,4,5,8,9 and 12-16* is/are rejected.

7)☒ Claim(s) *17* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *03 December 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 4, 5, 8, 9, and 12-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art (APA) in view of Min et al. (Applied Physics Letters Vol. 75, Number 11, 1999) and Chung et al. (U.S. 2003/0108674).

Regarding claims 1 and 13-16, APA teaches a method for forming a barrier metal of a semiconductor device, comprising forming an insulating layer on a semiconductor substrate and forming a contact hole opening in the insulating layer (instant specification pg. 2, line 15 – pg. 3, line 2). APA does not teach forming a TiSiN layer having a desired thickness by repeatedly performing a process of forming a TiSiN layer having an atomic layer thickness in a reaction chamber, wherein the process of forming a TiSiN layer having an atomic layer thickness comprises performing deposition of a Si layer inside the opening and on the insulating layer using an atomic layer deposition process, discharging a gas remaining in the reaction chamber by using an inert gas, performing deposition of a certain precursor layer on the Si layer, and discharging a gas of precursor material remaining n the raction chamber by using an inert gas; and performing plasma processing for the TiSiN layer so as to remove impurities contained in the TiSiN layer.

Min et al. teaches a method for forming a barrier metal of a semiconductor device, comprising forming a TiSiN layer having a desired thickness by repeatedly performing a process of forming a TiSiN layer having an atomic layer thickness (pg. 1521, paragraph 2) in a reaction chamber, wherein the process of forming a TiSiN layer having an atomic layer thickness comprises performing deposition of a Si layer inside the opening and on the insulating layer using an atomic layer deposition process, discharging a gas remaining in the reaction chamber by using an inert gas (argon—further limited by claim 16; pg. 1521, fourth paragraph), performing deposition of a certain precursor layer on the Si layer (pg. 1521, paragraphs 2-4; Min et al. teaches a cyclical MOALD technique of sequentially supplying TDMAT, SiH_4, and NH_3 to provide sequential Ti-Si-N layers. By the second cycle, TDMAT is deposited on top of the first Si layer, which is on top of the substrate, as required by instant claim 1), and discharging a gas of precursor material remaining in the reaction chamber by using an inert gas (argon—further limited by claim 16; pg. 1521, fourth paragraph). Min et al. does not teach plasma processing the TiSiN layer to remove impurities.

Chung et al. teaches plasma processing a TiSiN layer to decrease the resistivity of the layer (paragraph 0041). Chung et al. does not expressly teach that this plasma processing removes impurities, but does teach using a combination of nitrogen and hydrogen, the same plasma disclosed by Applicant in lines 12-20 of page 9 of the instant specification to reduce CH-based impurities. It is therefore inherent that the plasma processing taught by Chung et al. also has the effect of removing impurities from the TiSiN layer.

Therefore, at the time of the invention, it would have been obvious to combine the teachings of APA and Min et al. to form an insulating layer on a semiconductor substrate and form an opening in the insulating layer, as taught by APA, and then use the MOALD technique taught by Min et al. to deposit a TiSiN layer having a desired thickness. The motivation for doing so at the time of the invention would have been because MOALD techniques achieve near-perfect step coverage and can control precisely the thickness and composition of grown films, which is important when providing copper barrier diffusion materials to small-scale semiconductor devices, as expressly taught by Min et al. (pg. 1521, paragraphs 1 and 2).

It would further be obvious to combine the teachings of Chung et al. with the combined teachings of APA and Min et al. to plasma-process, using a plasma processed under an atmosphere of a nitrogen gas and a hydrogen gas, the TiSiN layer to remove CH-based impurities—further limited by claim 13. The motivation for doing so at the time of the invention would be to lower the resistance of the TiSiN layer, as expressly taught by Chung et al.

Regarding claims 4, 5, and 8, APA, Min et al., and Chung et al. together teach the method of claim 1. Min et al. further teaches that the Si layer is deposited using an SiH_4 gas and that the precursor layer is formed by TDMAT (pg. 1251, paragraph 2).

Regarding claims 9 and 12, APA, Min et al., and Chung et al. together teach the method of claims 5 and 8. Chung et al. further teaches using atomic layer deposition to form a layer of TiSiN using TDMAT as a precursor (paragraph 0070) at a temperature ranging from 350 to 450°C (paragraph 0031).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to use the method taught by the combined teachings of APA and Min et al., and further use a temperature ranging from 350 to 450°C, as taught by Chung et al., since Chung et al. demonstrates that this temperature range is known in the art of semiconductor processing to be a effective for atomic layer deposition of TiSiN using TDMAT as a precursor.

Allowable Subject Matter

Claim 17 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter:

Prior art does not teach or suggest, in combination with the other claimed limitations, an ALD technique of forming a TiSiN layer having an atomic layer thickness at a pressure between 90 and 300 Torr. Min et al. teaches a pressure of 1 Torr (133 Pa).

Response to Arguments

Applicant's arguments regarding claims 1, 4, 5, 8, and 13-15 filed 11/22/2005 have been fully considered but they are not persuasive.

Applicant argues on page 4 that Min et al. does not disclose or suggest discharging gas remaining the reactor or discharging a gas of precursor material remaining in the reaction chamber by using an inert gas.

However, this argument is not persuasive because, as pointed out by Applicant, Min et al. does teach using argon, an inert gas, between each reactant gas pulse to isolate the reactant gases from each other. In order to effectively isolate one gas from another in a cyclic process, each gas must be purged from the reactor before the next is introduced. Min et al. discloses using argon to perform this function.

Applicant's arguments regarding the reference Chen et al. (U.S. 6, 596,643) have been considered but are moot in view of the new grounds of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Heather A. Doty, whose telephone number is 571-272-8429. The examiner can normally be reached on M-F, 8:30 - 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Carl Whitehead

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